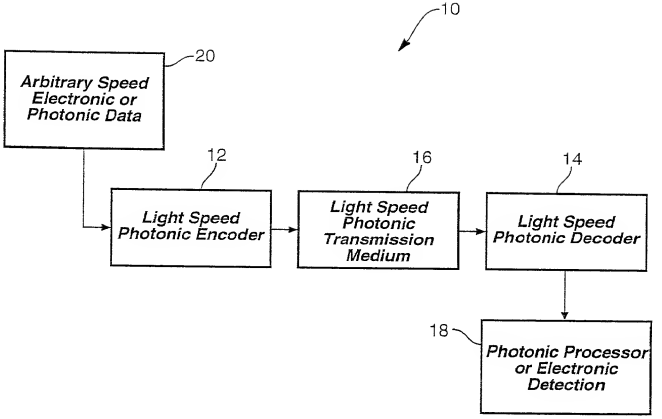

10
20
Arbitrary Speed Electronic or Photonic Data
12
Light Speed Photonic Encoder
16
Light Speed Photonic Transmission Medium
14
Light Speed Photonic Decoder
18
Photonic Processor or Electronic Detection

FIG. 1

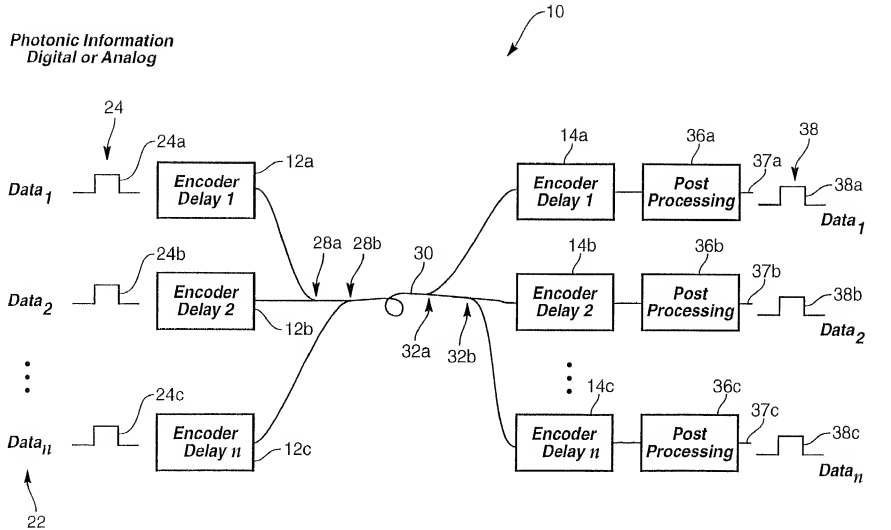
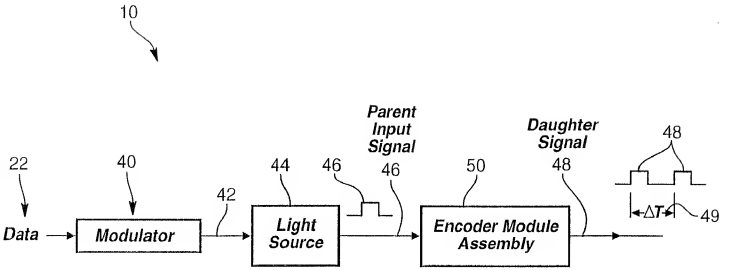
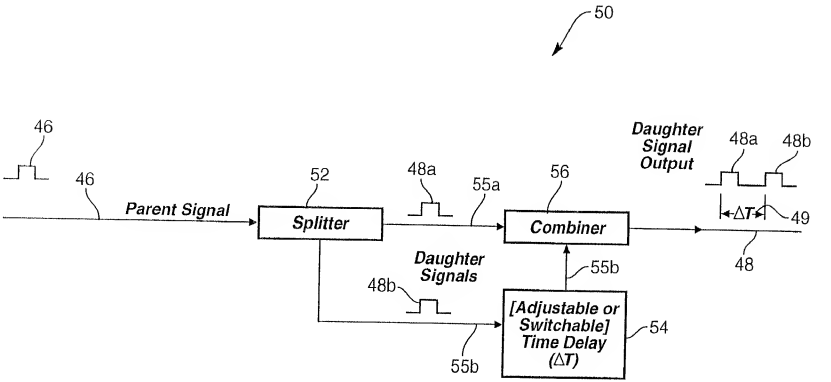

Photonic Information
Digital or Analog
10
24
24a
24b
24c
Data 1
Data 2
Data n
22
Encoder Delay 1
Encoder Delay 2
Encoder Delay n
12a
12b
12c
28a
28b
30
32a
32b
14a
14b
14c
36a
36b
36c
Post Processing
37a
37b
37c
38
38a
38b
38c
Data 1
Data 2
Data n

Fig. 2



Differential Delay Multiplexer Sender/Encoder

Fig. 3



Differential Delay Multiplexer (DDM) Sender/Encoder

Fig. 4

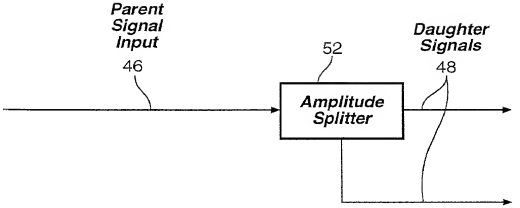
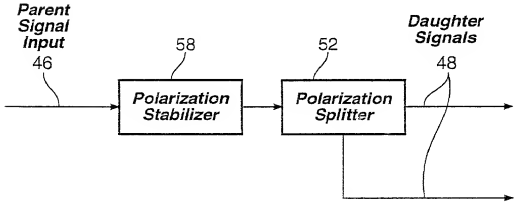
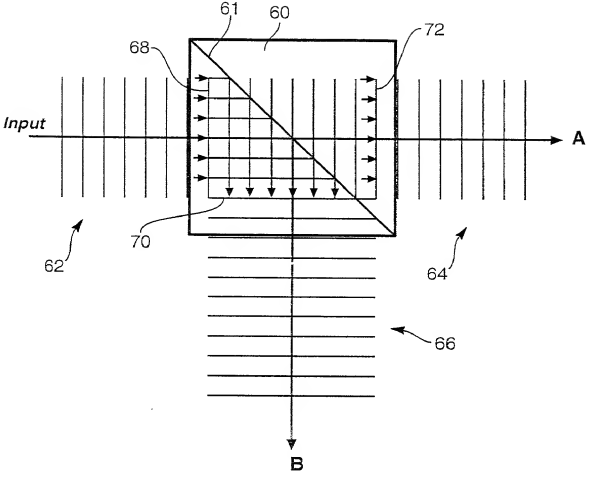


FIG. 5



Splitting Criteria

FIG. 6



Amplitude or Polarization Splitter

FIG. 7

FOREIGN-FILED

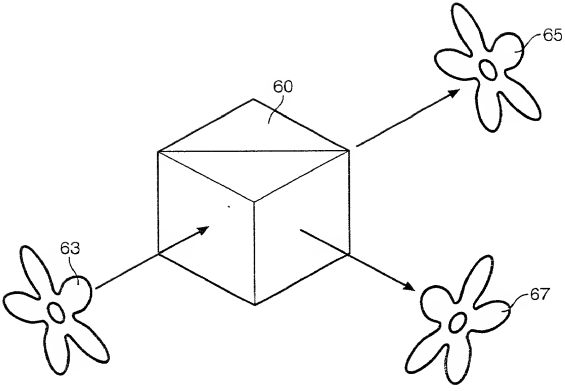
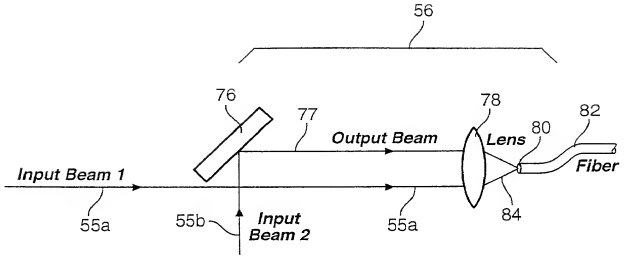


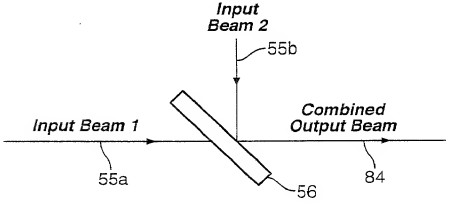
Image Signals Which
Maintain Spatial Information

FIG. 7A



Beam Combiner

FIG. 8



Amplitude or Polarization Combiner

FIG. 9

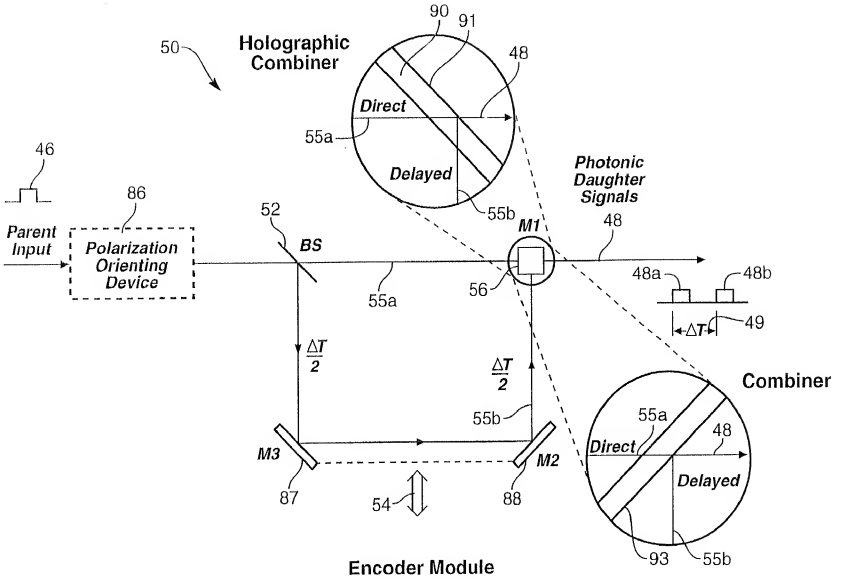
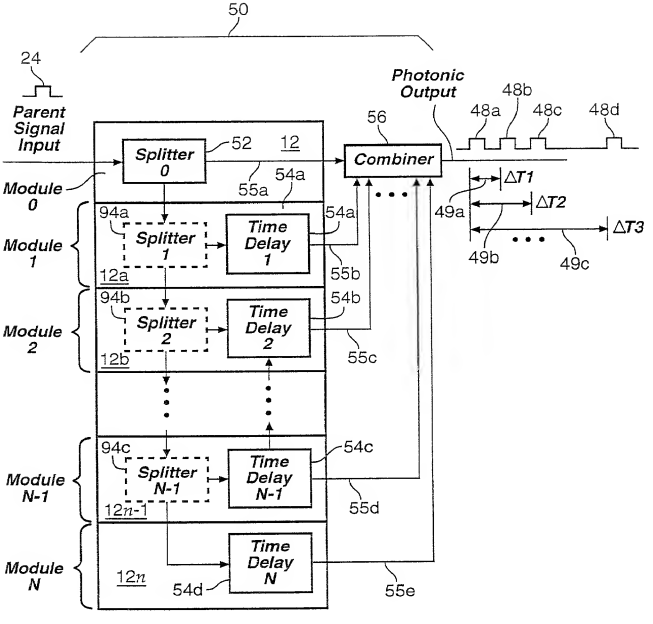

50
Holographic Combiner
90
91
48
Direct
55a
Delayed
55b
46
86
Parent Input
Polarization Orienting Device
52
BS
M1
Photonic Daughter Signals
48
48a
48b
ΔT
49
55a
56
ΔT/2
ΔT/2
55b
Combiner
55a
48
Direct
Delayed
M3
M2
87
54
88
93
55b
Encoder Module

Fig. 10



Composite Encoder Module Assembly

FIG. 11

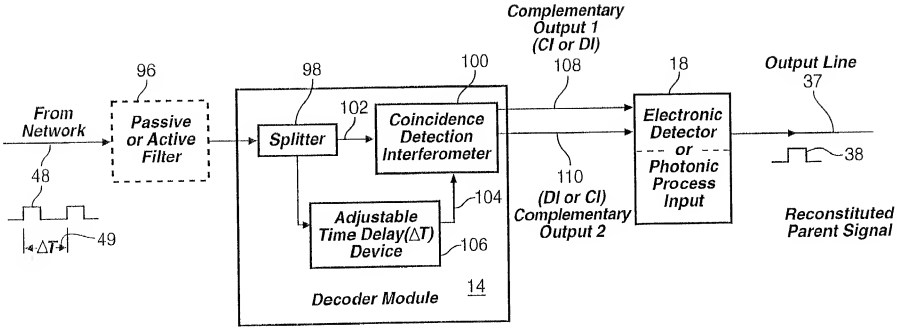

From Network
48
ΔT
49
96
Passive or Active Filter
98
Splitter
102
100
Coincidence Detection Interferometer
104
Adjustable Time Delay(ΔT) Device
106
Decoder Module
14
Complementary Output 1 (CI or DI)
108
110
(DI or CI) Complementary Output 2
18
Electronic Detector
or
Photonic Process Input
Output Line
37
38
Reconstituted Parent Signal

Fig. 12

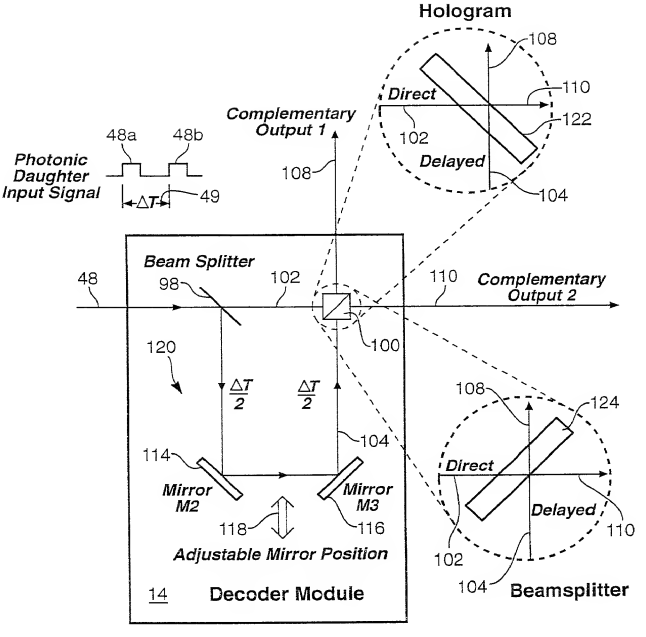

Hologram
108
110
Direct
122
102
Delayed
104
Complementary Output 1
48a
48b
Photonic Daughter Input Signal
ΔT
49
108
Beam Splitter
48
98
102
110
Complementary Output 2
100
120
ΔT/2
ΔT/2
104
114
Mirror M2
Mirror M3
118
116
Adjustable Mirror Position
14
Decoder Module
108
124
Direct
Delayed
110
102
104
Beamsplitter

FIG. 13

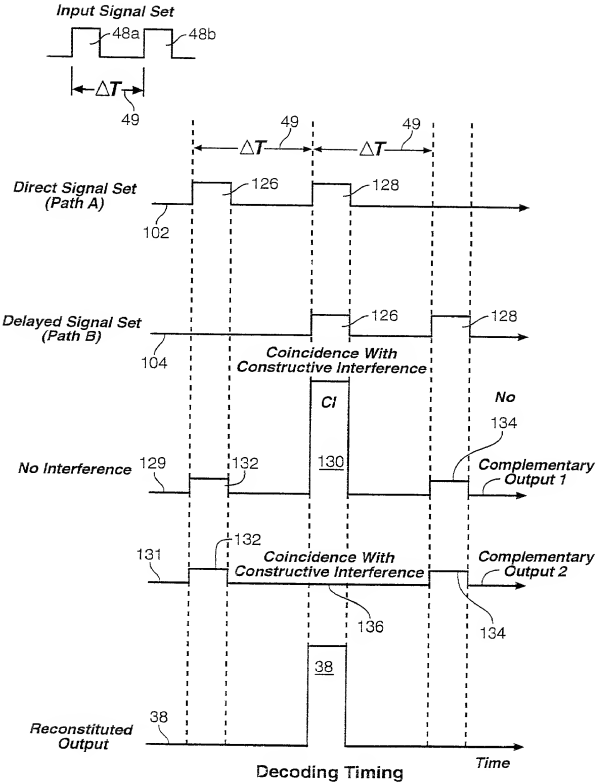

Input Signal Set
48a
48b
ΔT
49
49
ΔT
49
ΔT
Direct Signal Set
(Path A)
126
128
102
Delayed Signal Set
(Path B)
126
128
104
Coincidence With
Constructive Interference
CI
No
134
No Interference
129
132
130
Complementary
Output 1
131
132
Coincidence With
Constructive Interference
Complementary
Output 2
136
134
38
38
Reconstituted
Output
Time
Decoding Timing

FIG. 14

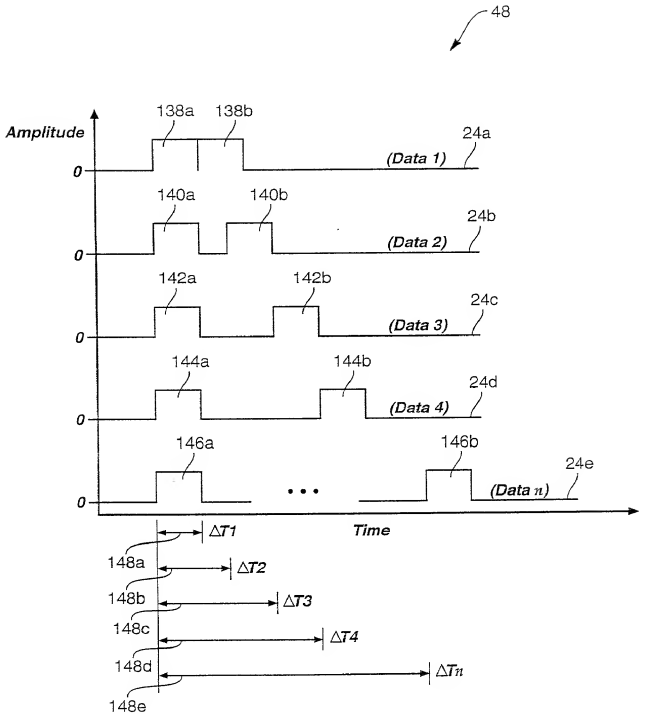

48
Amplitude
0
138a
138b
24a
(Data 1)
140a
140b
24b
(Data 2)
142a
142b
24c
(Data 3)
144a
144b
24d
(Data 4)
146a
146b
24e
(Data n)
Time
ΔT1
148a
ΔT2
148b
ΔT3
148c
ΔT4
148d
ΔTn
148e

Fig. 15

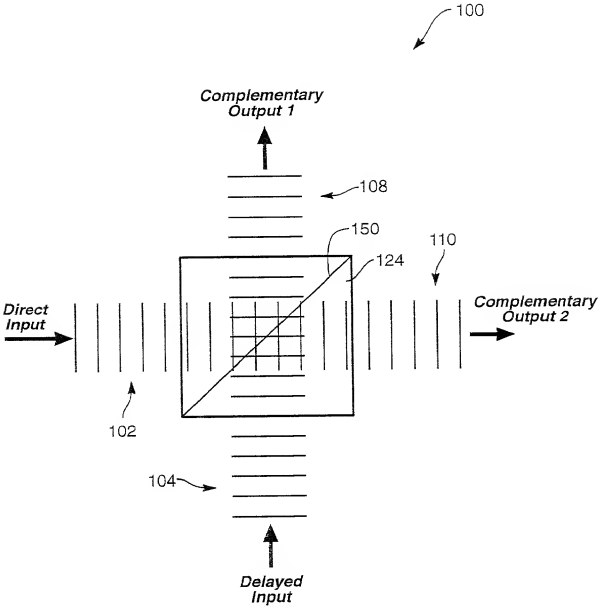

100
Complementary Output 1
108
150
110
124
Direct Input
Complementary Output 2
102
104
Delayed Input

Fig. 16

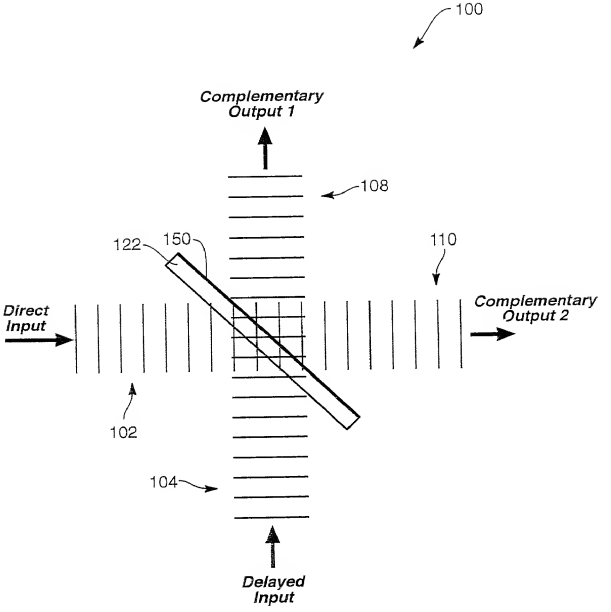

100
Complementary Output 1
108
122
150
110
Direct Input
Complementary Output 2
102
104
Delayed Input

Fig. 17

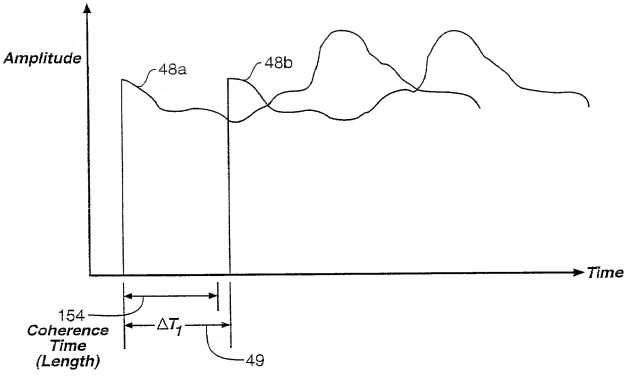

Amplitude
48a
48b
Time
154
Coherence
Time
(Length)
ΔT_1
49

Fig. 18

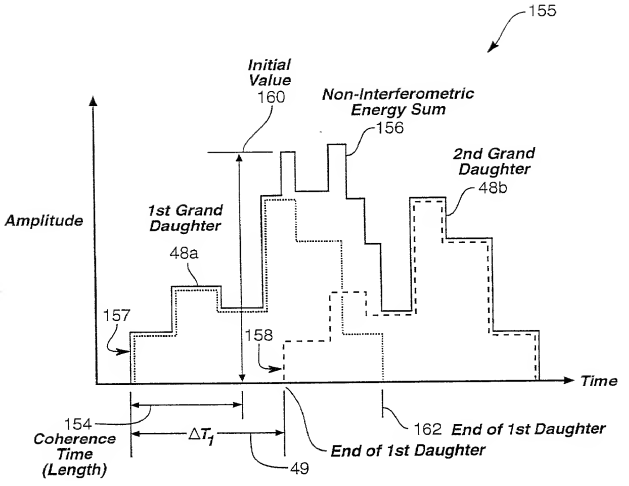

155
Initial Value
160
Non-Interferometric Energy Sum
156
2nd Grand Daughter
48b
Amplitude
1st Grand Daughter
48a
157
158
Time
154
Coherence Time (Length)
ΔT_1
49
End of 1st Daughter
162
End of 1st Daughter

Fig. 19

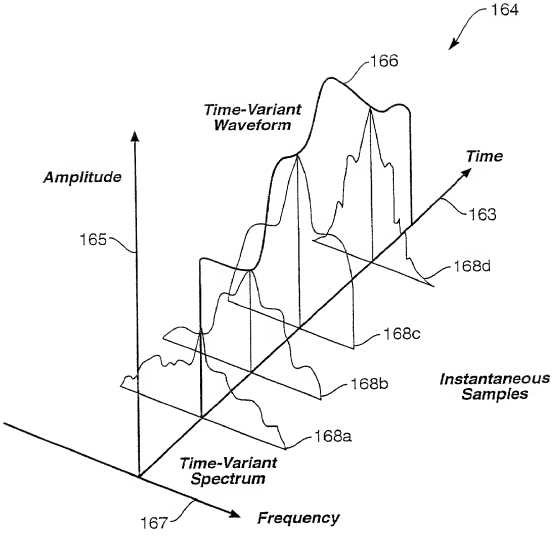

164
166
Time-Variant
Waveform
Amplitude
Time
163
165
168d
168c
168b
Instantaneous
Samples
168a
Time-Variant
Spectrum
167
Frequency

Fig. 20

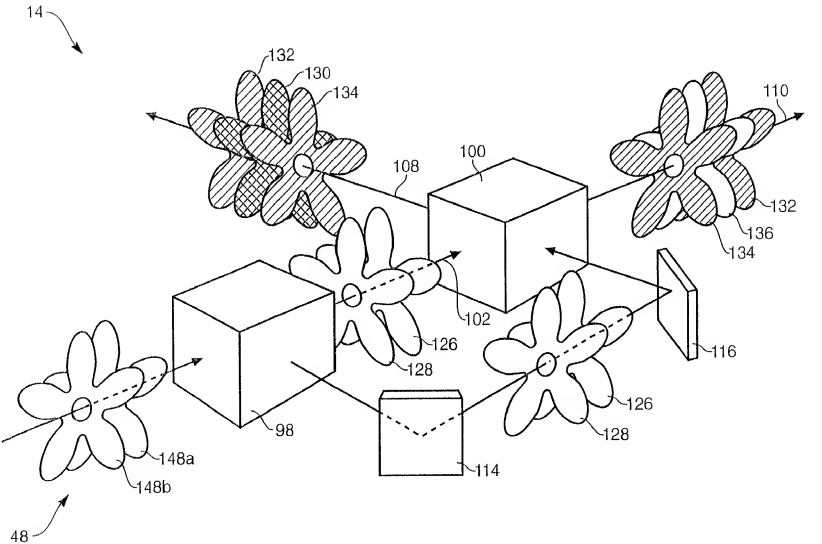
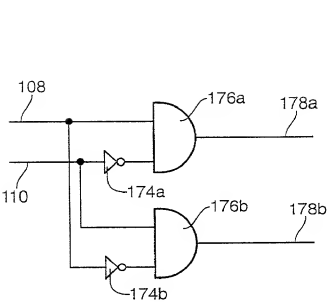
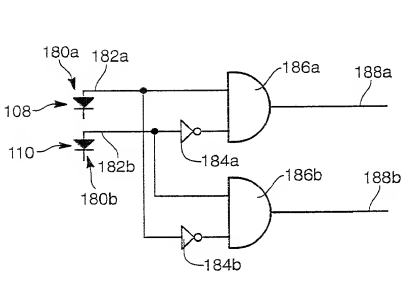

14
132
130
134
108
100
110
132
136
134
102
126
128
116
126
128
98
148a
148b
114
48

Fig. 21



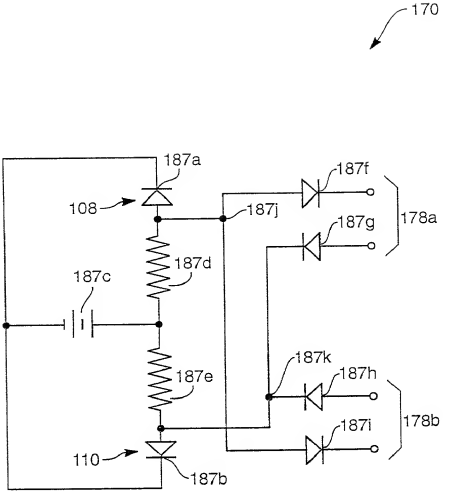
Photonic Processor

Fig. 22



Electronic Processor

Fig. 23A



Electronic Processor

Fig. 23B

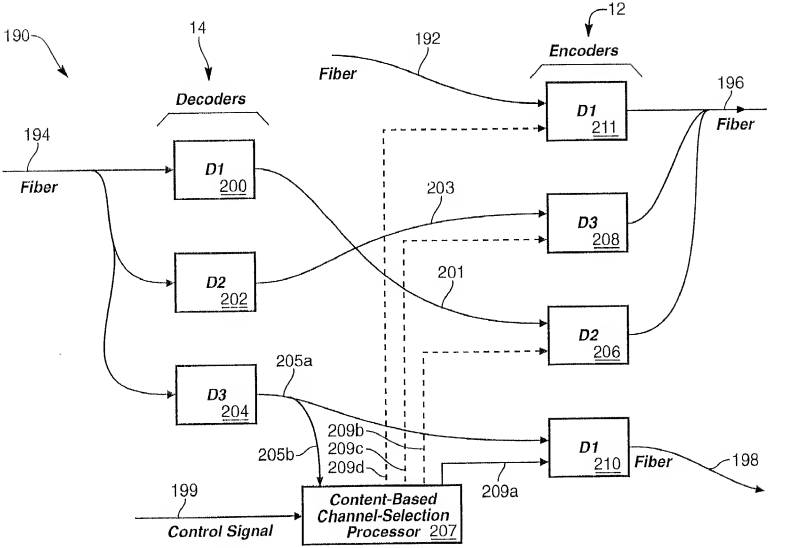
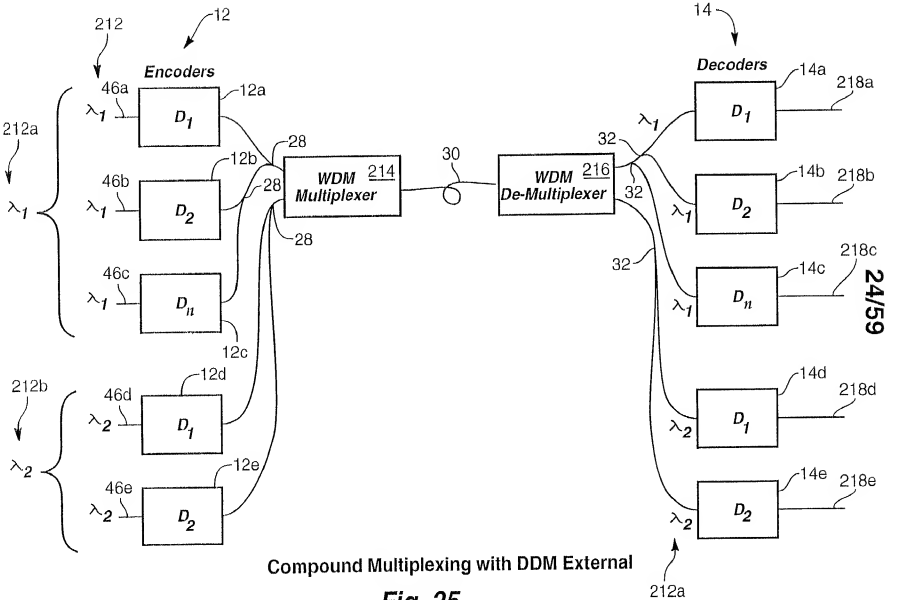

190
14
Decoders
Fiber
194
D1
200
D2
202
D3
204
205a
205b
209b
209c
209d
199
Control Signal
Content-Based
Channel-Selection
Processor 207
209a
192
Fiber
12
Encoders
D1
211
196
Fiber
203
D3
208
201
D2
206
D1
210
Fiber
198
Drop/Rearrange/Add
Unbuilding/Rebuilding

Fig. 24

TOSTSD: 03376360



Compound Multiplexing with DDM External

Fig. 25

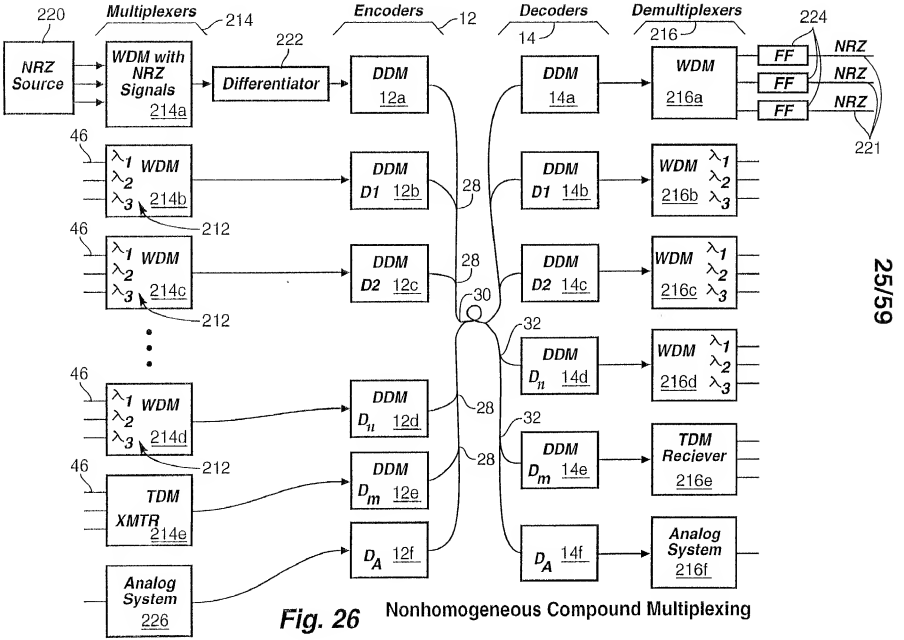
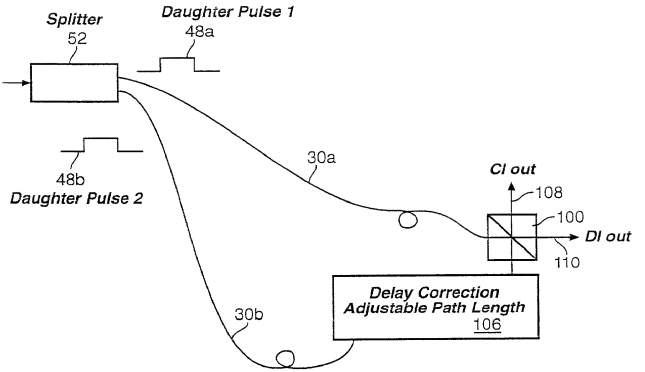


Fig. 26 Nonhomogeneous Compound Multiplexing



Multiple Delay Path

Integrated Delay and
Delay Correction

FIG. 27

RECTIFIED

Photonic NRZ Interface

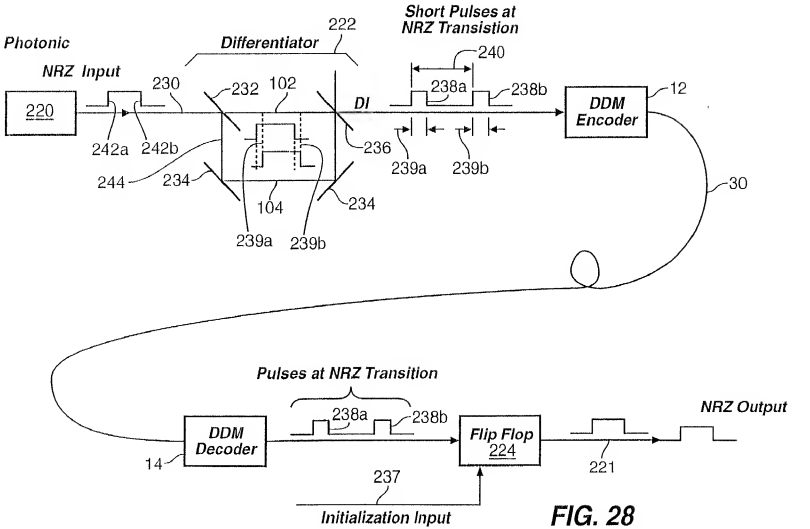


FIG. 28

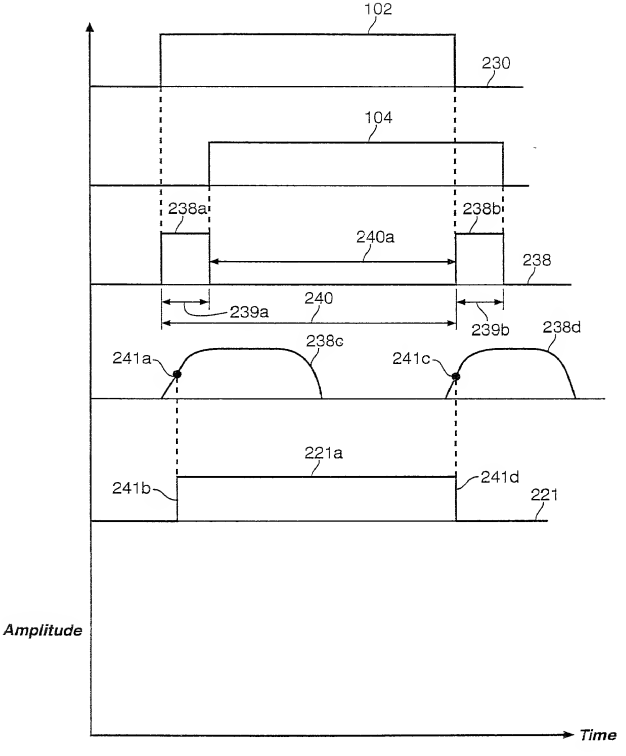
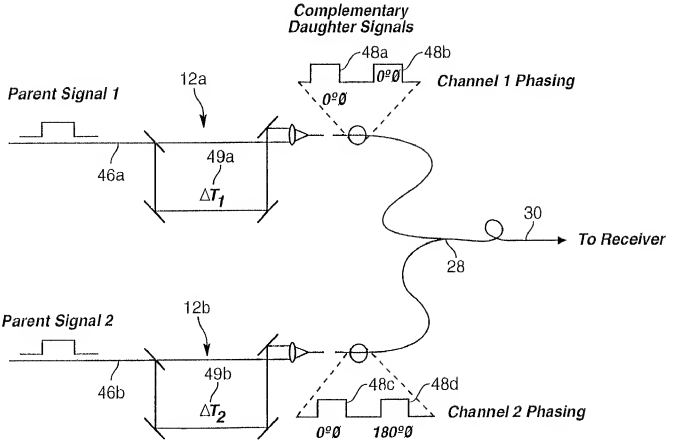

102
230
104
238a
238b
240a
238
240
239a
239b
238d
238c
241a
241c
221a
241b
241d
221
Amplitude
Time

FIG. 29



Phase Sequenced Dual Channel Encoder

FIG. 30

Phase Sequenced Dual Channel Decoder

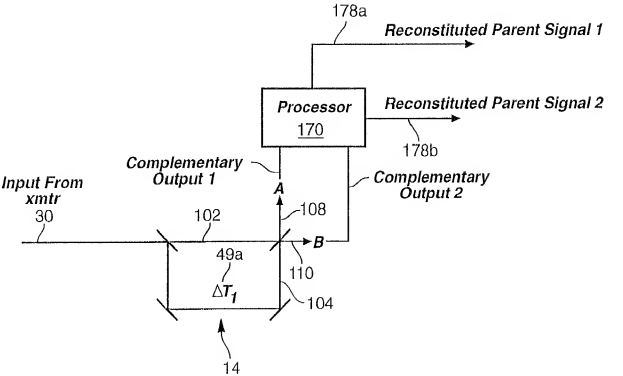


FIG. 31

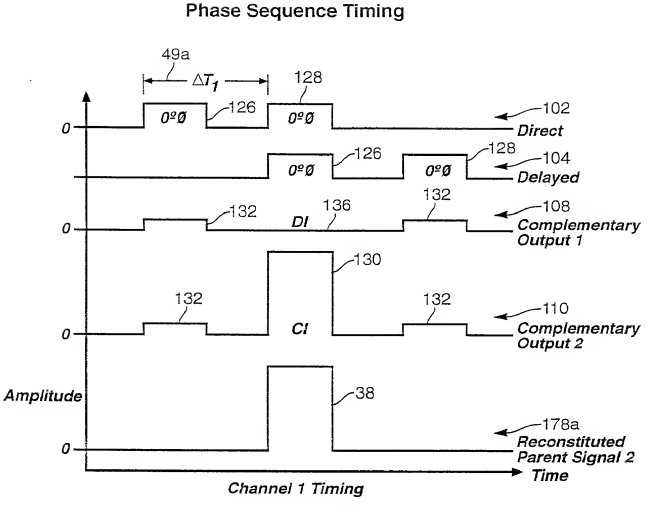

Phase Sequence Timing
49a
ΔT_1
128
126
0ºØ
102
Direct
104
Delayed
132
136
DI
108
Complementary Output 1
130
CI
110
Complementary Output 2
Amplitude
38
178a
Reconstituted Parent Signal 2
0
Time
Channel 1 Timing

FIG. 32

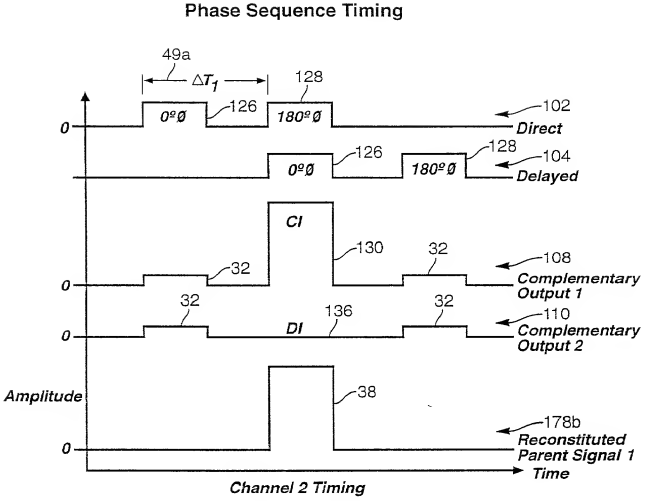

Phase Sequence Timing
49a
ΔT_1
128
126
0º Ø
180º Ø
102
Direct
126
128
0º Ø
180º Ø
104
Delayed
CI
130
32
32
108
Complementary Output 1
32
136
32
DI
110
Complementary Output 2
Amplitude
38
178b
Reconstituted Parent Signal 1
0
Time
Channel 2 Timing

FIG. 33

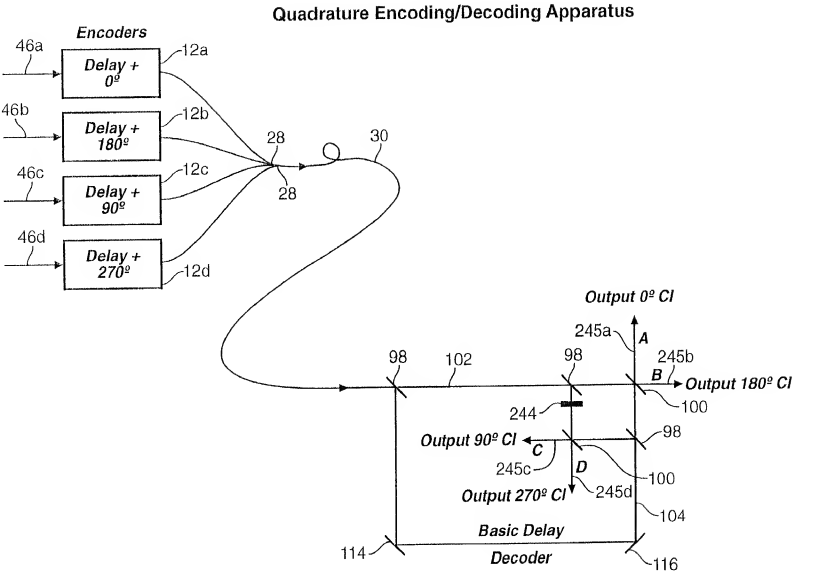

Quadrature Encoding/Decoding Apparatus
Encoders
46a
Delay + 0º
12a
46b
Delay + 180º
12b
28
30
46c
Delay + 90º
12c
28
46d
Delay + 270º
12d
Output 0º CI
245a
A
98
102
98
245b
B
Output 180º CI
244
100
Output 90º CI
C
98
245c
D
100
Output 270º CI
245d
104
Basic Delay
114
Decoder
116

FIG. 34

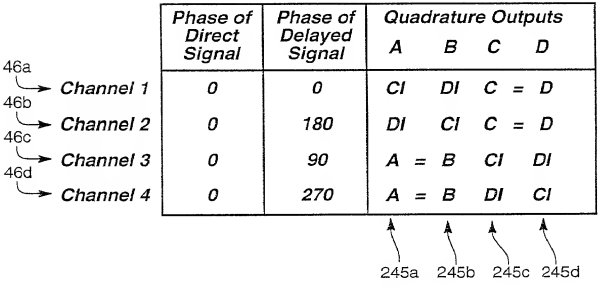

Phase of Direct Signal
Phase of Delayed Signal
Quadrature Outputs
A B C D
46a
Channel 1
0
0
CI DI C = D
46b
Channel 2
0
180
DI CI C = D
46c
Channel 3
0
90
A = B CI DI
46d
Channel 4
0
270
A = B DI CI
245a
245b
245c
245d

FIG. 35

Quadrature Wave Forms For One Channel

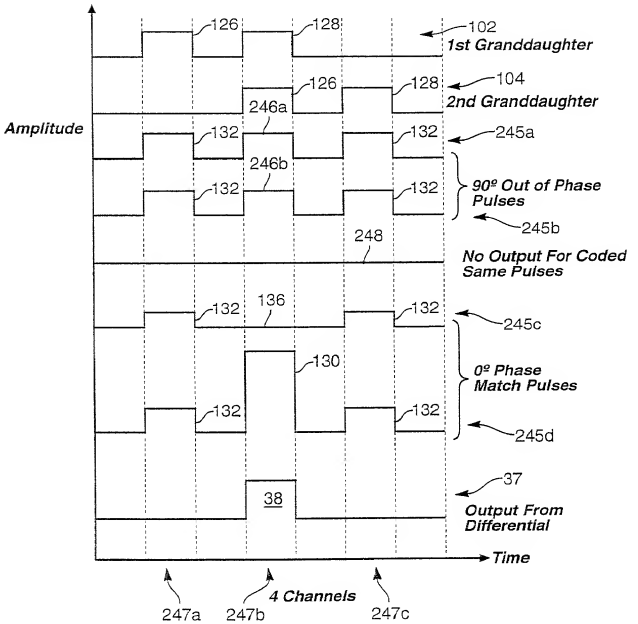


FIG. 36

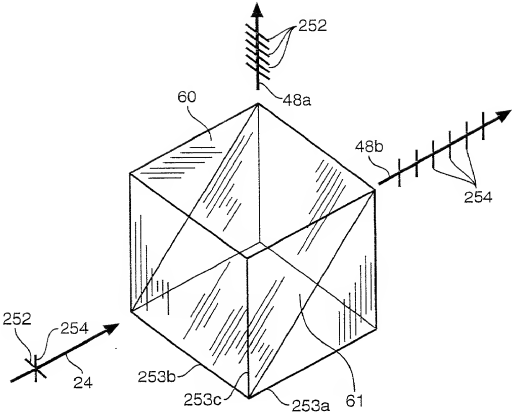


FIG. 37A

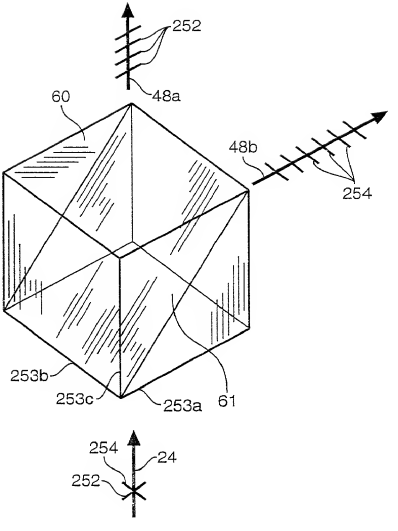
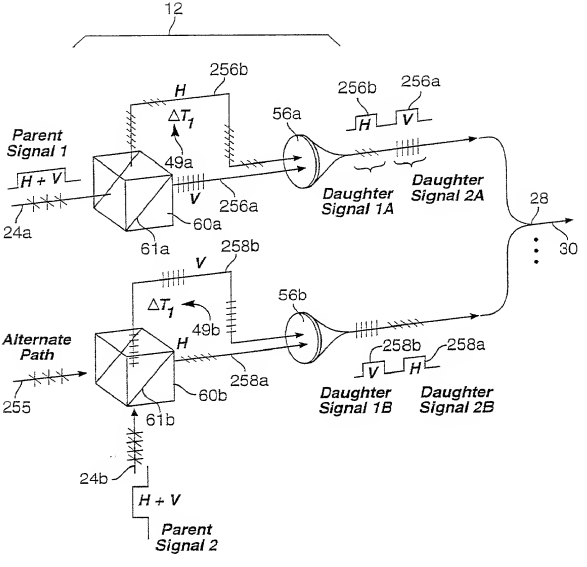
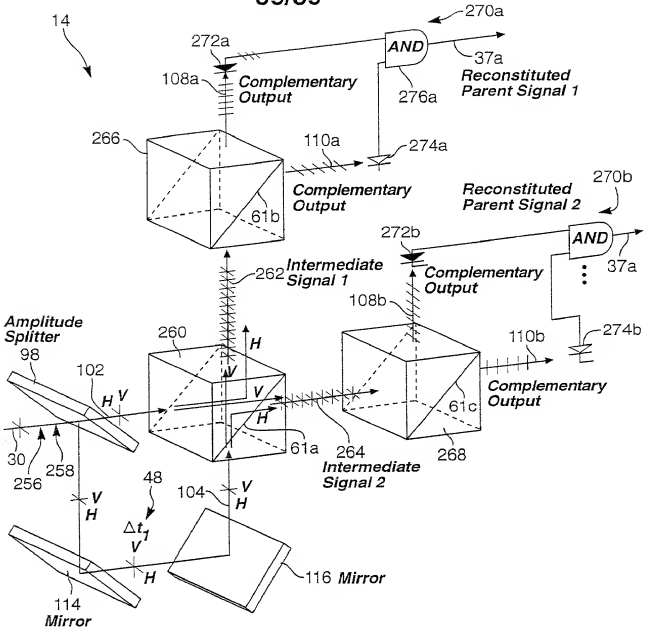


FIG. 37B



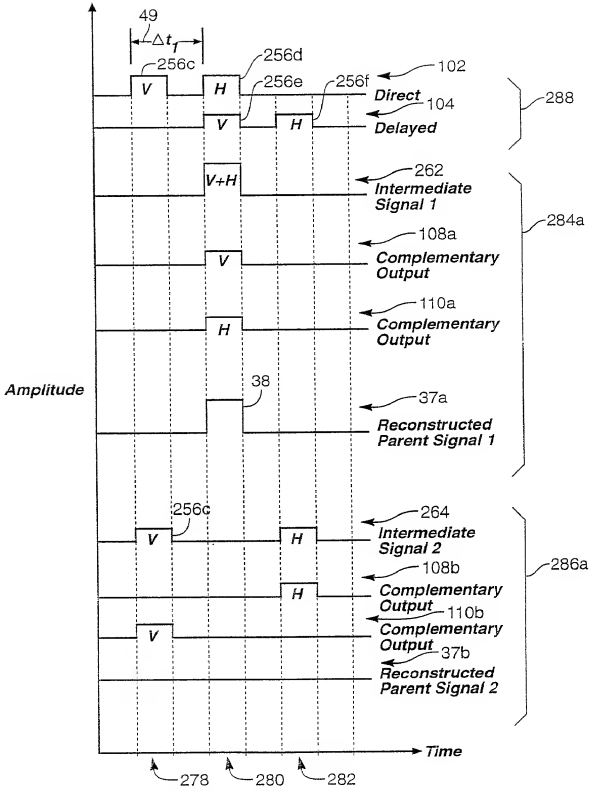
Double Encoder With Polarizations Sequenced to Differentiate 2 Channels Having the Same Time Delay Between Daughter Signals

FIG. 38



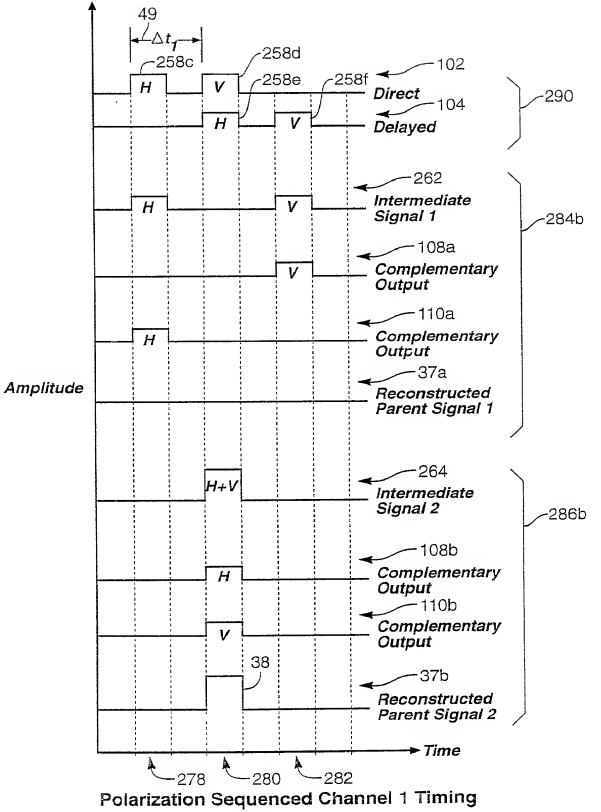
Double Decoder With Polarizations Sequenced to Differentiate 2 Channels Having the Same Time Delay Between Daughter Signals

FIG. 39



Polarization Sequenced Channel 1 Timing

FIG. 40



Polarization Sequenced Channel 1 Timing

FIG. 41

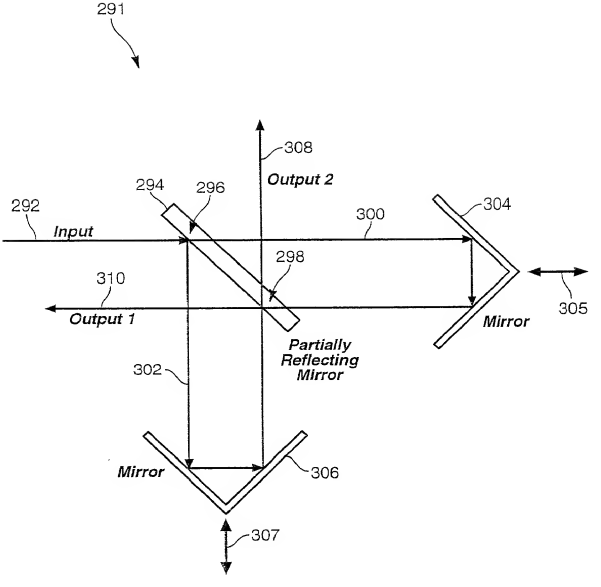

291
308
Output 2
294
296
292
Input
300
304
298
310
Output 1
305
Mirror
Partially
Reflecting
Mirror
302
Mirror
306
307

FIG. 42

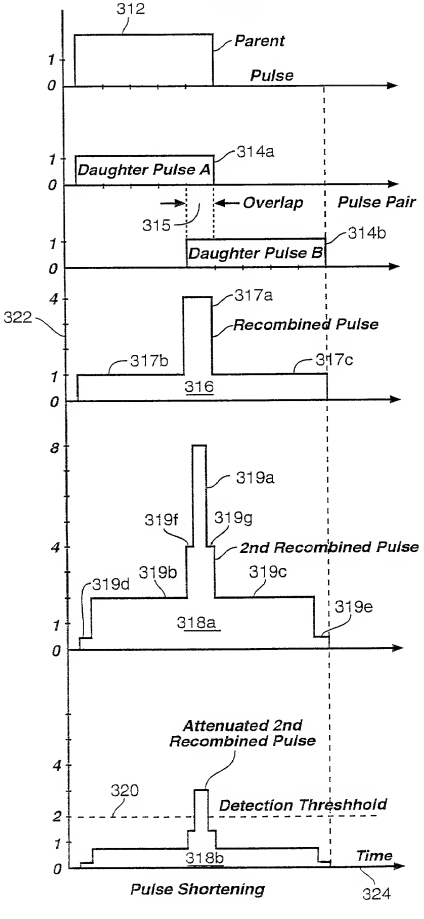

312
Parent
Pulse
1
0
Daughter Pulse A
314a
Overlap
Pulse Pair
315
Daughter Pulse B
314b
4
322
317a
Recombined Pulse
317b
317c
316
8
319a
319f
319g
2nd Recombined Pulse
319b
319c
319d
319e
318a
Attenuated 2nd
Recombined Pulse
320
Detection Threshhold
2
318b
Time
Pulse Shortening
324

FIG. 43

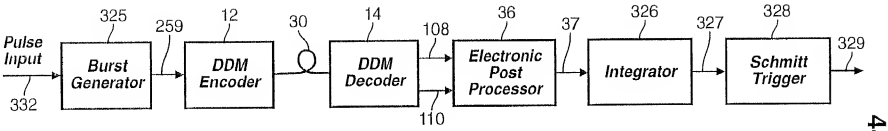

Pulse Input
332
325
Burst Generator
259
12
DDM Encoder
30
14
DDM Decoder
108
110
36
Electronic Post Processor
37
326
Integrator
327
328
Schmitt Trigger
329

FIG. 44

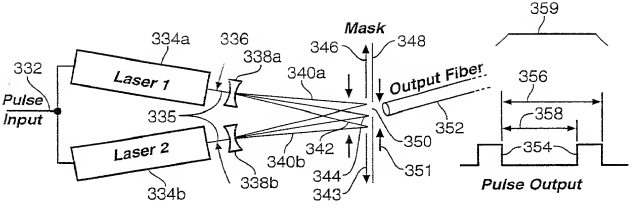

359
Mask
334a
336
346
348
338a
332
Laser 1
340a
Output Fiber
356
Pulse
Input
335
352
358
350
Laser 2
342
340b
354
344
338b
351
334b
343
Pulse Output

FIG. 45

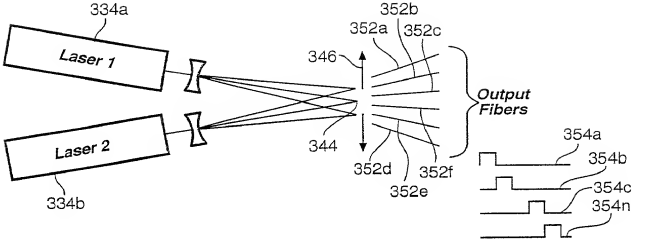

334a
Laser 1
Laser 2
334b
352b
352a
352c
346
344
352d
352e
352f
Output Fibers
354a
354b
354c
354n

FIG. 46

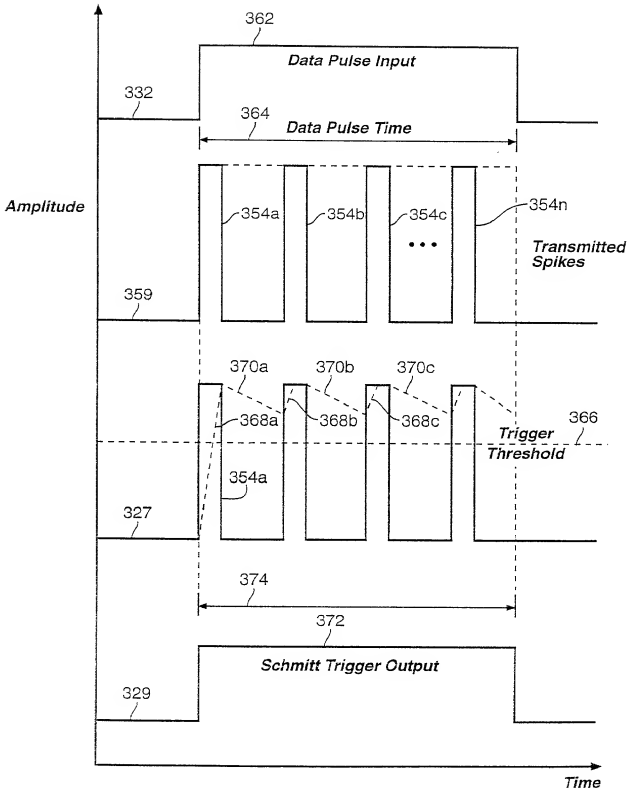

362
Data Pulse Input
332
364
Data Pulse Time
Amplitude
354a
354b
354c
354n
Transmitted Spikes
359
370a
370b
370c
368a
368b
368c
366
Trigger Threshold
354a
327
374
372
Schmitt Trigger Output
329
Time

FIG. 47

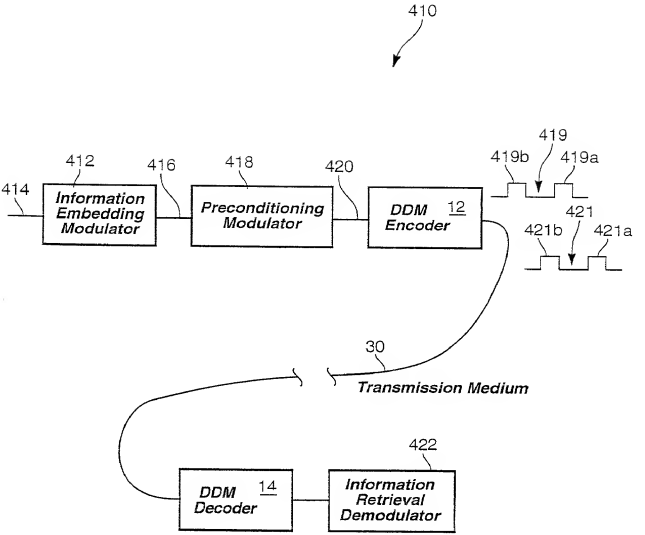

410
412
414
Information Embedding Modulator
416
418
Preconditioning Modulator
420
DDM 12 Encoder
419
419b
419a
421
421b
421a
30
Transmission Medium
422
DDM 14 Decoder
Information Retrieval Demodulator

FIG. 48

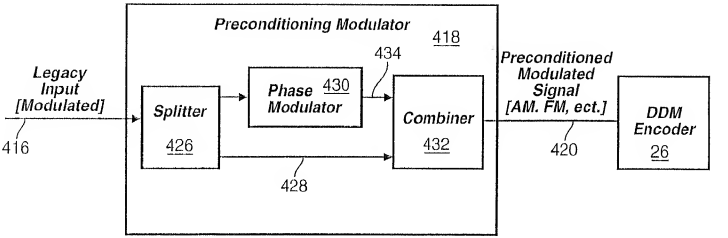

Preconditioning Modulator
418
434
Legacy
Input
[Modulated]
416
Splitter
426
Phase
Modulator
430
Combiner
432
428
Preconditioned
Modulated
Signal
[AM. FM, ect.]
420
DDM
Encoder
26

FIG. 49

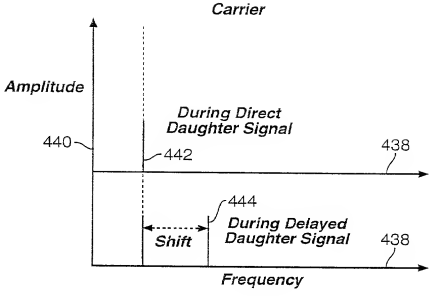

Carrier
Amplitude
During Direct
Daughter Signal
440
442
438
444
Shift
During Delayed
Daughter Signal
438
Frequency

FIG. 50

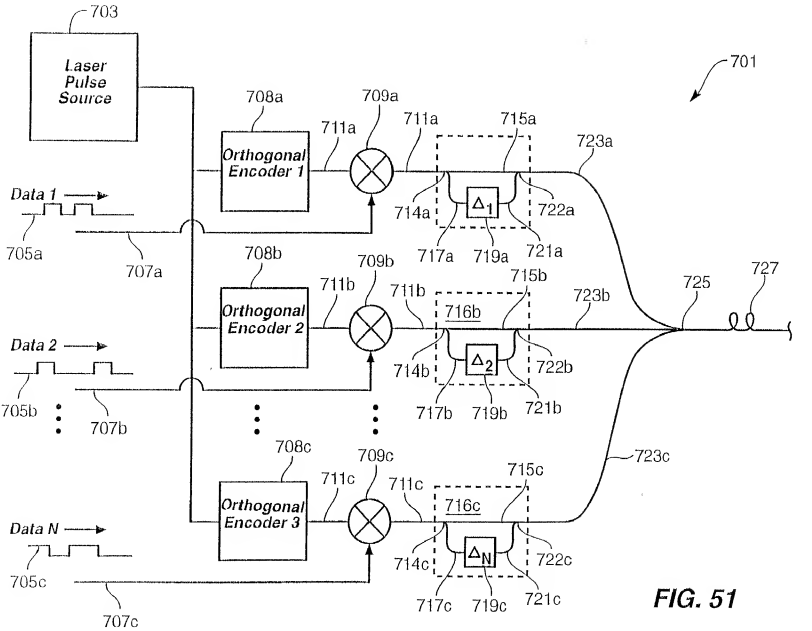

703
Laser Pulse Source
701
708a
709a
711a
711a
715a
723a
Orthogonal Encoder 1
Data 1
705a
707a
714a
Δ_1
722a
717a
719a
721a
708b
709b
711b
711b
715b
723b
725
727
Orthogonal Encoder 2
716b
Data 2
705b
707b
714b
Δ_2
722b
717b
719b
721b
708c
709c
711c
711c
715c
723c
Orthogonal Encoder 3
716c
Data N
705c
707c
714c
Δ_N
722c
717c
719c
721c

FIG. 51

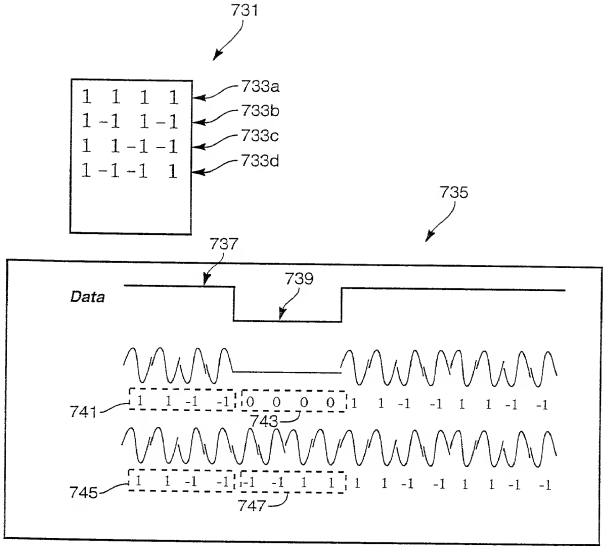

731
1 1 1 1
1 -1 1 -1
1 1 -1 -1
1 -1 -1 1
733a
733b
733c
733d
735
737
739
Data
741
1 1 -1 -1 0 0 0 0 1 1 -1 -1 1 1 -1 -1
743
745
1 1 -1 -1 -1 -1 1 1 1 1 -1 -1 1 1 -1 -1
747

FIG. 52

PCT/SU99/00050

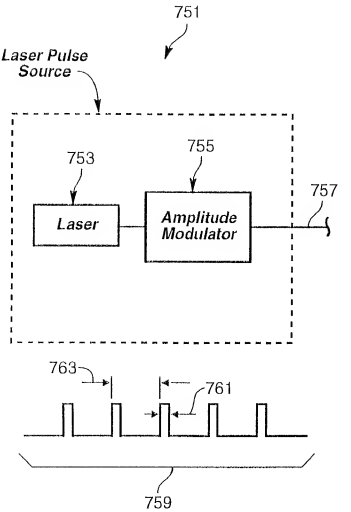


FIG. 53

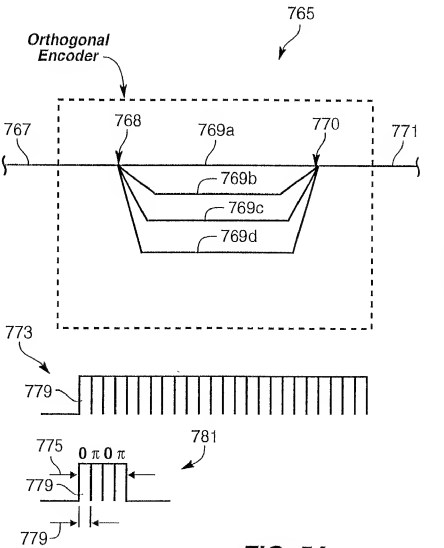
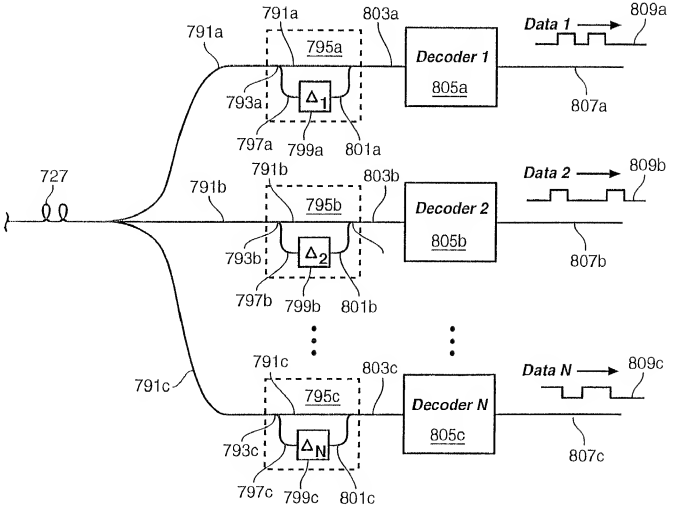


FIG. 54


727
791a
795a
803a
Decoder 1
805a
Data 1
809a
807a
793a
797a
799a
801a
Δ1
791b
795b
803b
Decoder 2
805b
Data 2
809b
807b
793b
797b
799b
801b
Δ2
791c
795c
803c
Decoder N
805c
Data N
809c
807c
793c
797c
799c
801c
ΔN

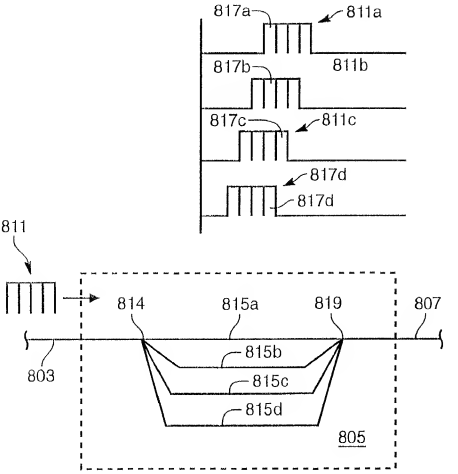

817a
811a
817b
811b
817c
811c
817d
817d
811
814
815a
819
807
803
815b
815c
815d
805

FIG. 56

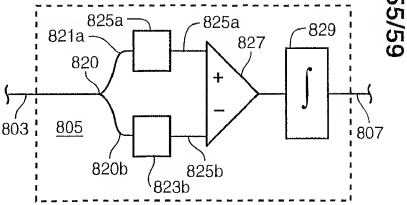

825a
825a
821a
827
829
820
+
−
803
805
807
820b
825b
823b

FIG. 57

Docket No. 1998-0600

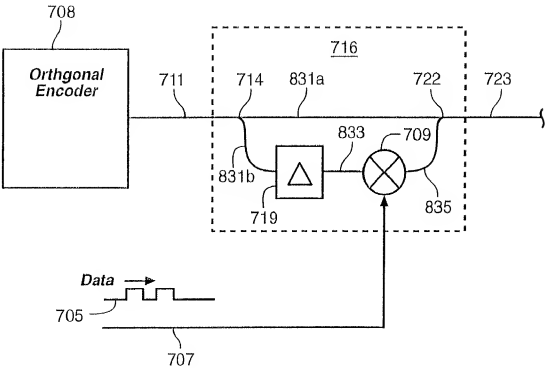


FIG. 58

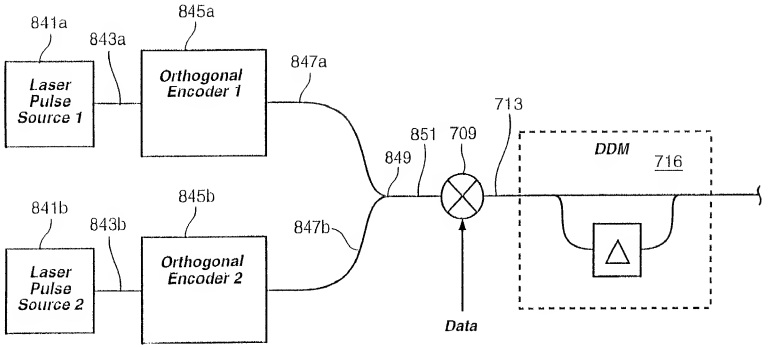

841a
843a
845a
Laser Pulse Source 1
Orthogonal Encoder 1
847a
841b
843b
845b
Laser Pulse Source 2
Orthogonal Encoder 2
847b
849
851
709
713
DDM
716
Data
855
853a
853b

FIG. 59

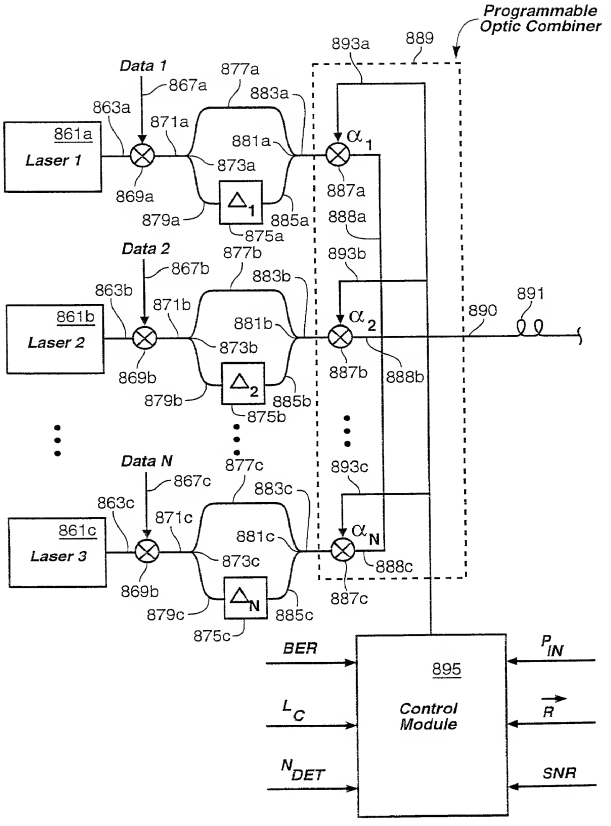

Programmable
Optic Combiner
889
893a
Data 1
867a
877a
883a
863a
871a
861a
Laser 1
881a
α_1
873a
869a
887a
Δ_1
879a
885a
888a
875a
Data 2
867b
877b
893b
863b
883b
891
871b
861b
Laser 2
881b
α_2
890
873b
869b
887b
888b
Δ_2
879b
885b
875b
Data N
867c
877c
893c
863c
883c
871c
861c
Laser 3
881c
α_N
873c
888c
869b
887c
Δ_N
879c
885c
875c
BER
L_C
N_{DET}
895
Control
Module
P_{IN}
$\vec{R}$
SNR

FIG. 60

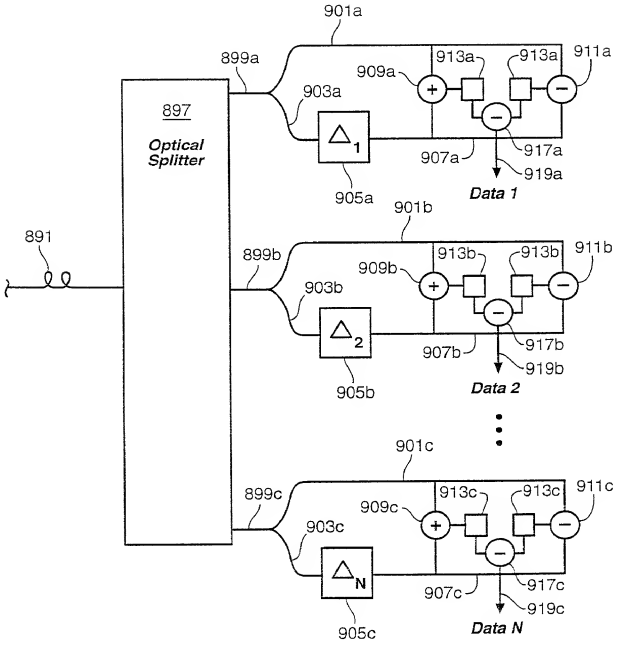

901a
899a
913a
913a
911a
909a
903a
897
Optical Splitter
Δ1
907a
917a
919a
905a
Data 1
901b
891
899b
913b
913b
911b
909b
903b
Δ2
907b
917b
919b
905b
Data 2
901c
899c
913c
913c
911c
909c
903c
ΔN
907c
917c
919c
905c
Data N

FIG. 61